MetroTel

Voice Network Analyzer

Model VNA-70A

INSTRUCTION MANUAL

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Voice Network Analyzer
Model VNA-70A

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1. INTRODUCTION

This document provides information on the Model VNA-70A Voice Network Analyzer Test Set. Included are descriptions of the instrument controls, functions, specifications and applications. The information is designed for test engineers and technicians.

2. GENERAL DESCRIPTION

The VNA-70A is a comprehensive telecom test instrument which offers several modes of operation designed specifically for the telecom environment. Model 70A is an enhanced version of the earlier Model 70 with the addition of Ohms test capability.

The test set acts as a DVOM, a frequency counter, oscillator, dialed digit display and milliammeter. This unique set of functions are selected to allow thorough troubleshooting of the local telephone loop and the premise equipment connected to it.

The instrument is battery powered. It connects to the telephone line via modular jacks and an alligator clip cordset. All results are shown on a single high-contrast screen for simple and speedy usage. Measurements are autoranging and true RMS. Functions include:

A. VOICE NETWORK TESTS — measures and simultaneously displays the following phone line parameters:

1. DC. voltage
2. DC loop current
3. DC polarity
4. AC signals in either dBm or AC volts
5 Signal frequency

In a separate mode, the VNA-70A measure resistance:

6. Ohms in loop and DC

TONE GENERATOR—generates a 1004 H: sinewave

C. DIGIT DISPLAY—displays numbers as they are dialed

D. AUDIO MONITOR—allows input signals to be monitored via a built-in speaker

In connection with these features, the VNA-70A may be operated in either of two modes:

LINE BRIDGING — allows measurements to be made without loading the phone line. Input signals may also be monitored via the built-in speaker.

LINE TERMINATING — applies a precise 600 Ohm AC load to the line while presenting a 50 to 300 Ohm effective DC resistance.

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3. CONTROLS

A. On/Off/Volume Control

B. Telephone Line Jack

C. Butt Set/CPE Jack

D. Setup Switch

E. Test Mode Switch

F. OHMS Switch

G. Audio Monitor Speaker

H. Display Screen; Super-Twist high contrast

I. Battery Charging Jack

J. Dial Pulse LEVEL SELECT
(located inside battery compartment)

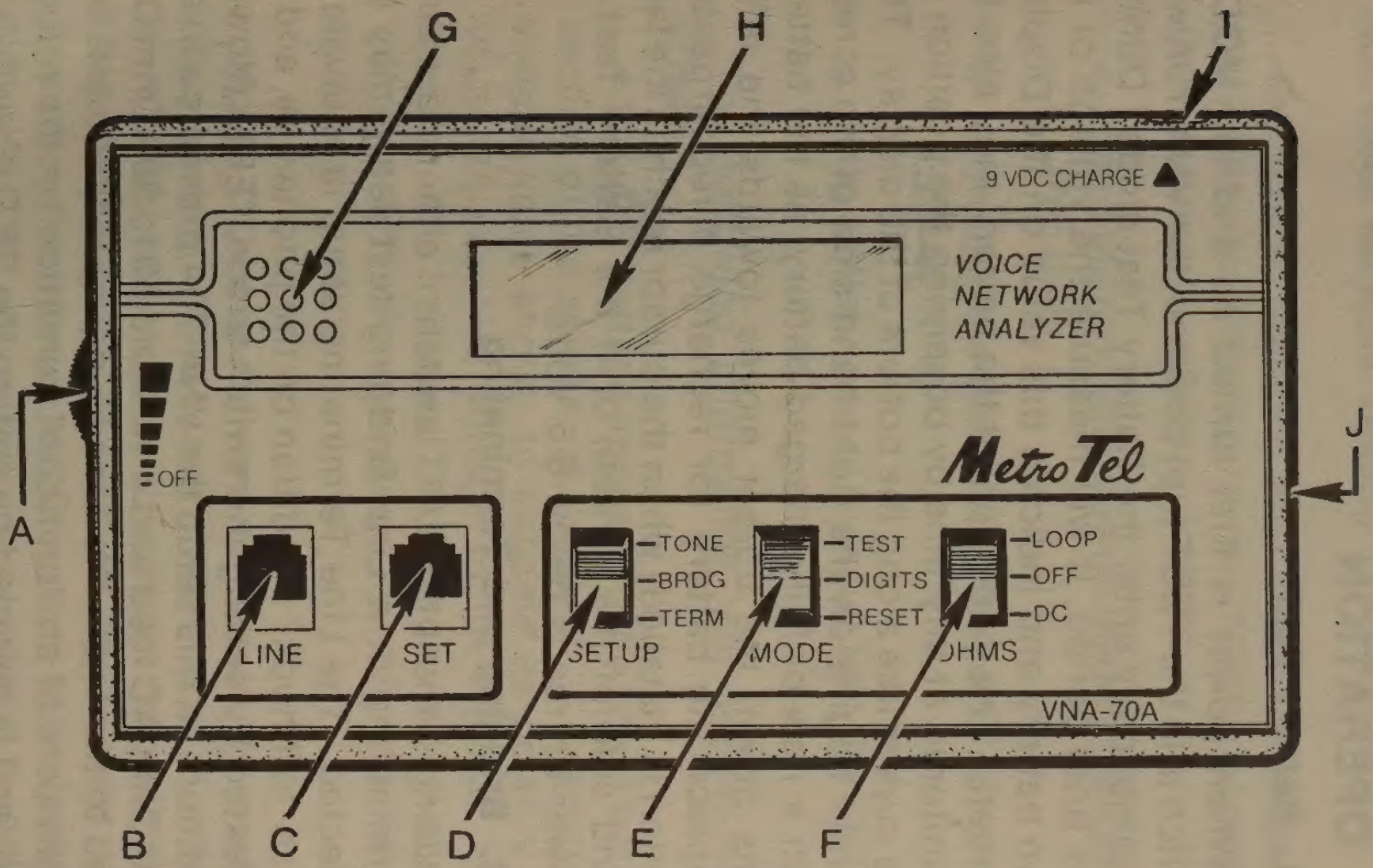


Figure 3-1: Instrument Controls

4. OPERATION

4.1. Battery Test

When power is first turned on and the MOD switch is in the TEST (up) position, the VNA-70A wi automatically enter the Battery Test mode. Durin this brief period, it will measure the voltage of it own battery and indicate this value on the Displa Screen. The condition of the battery may also b monitored at any time by observing the position o the cursor line along the bottom of the display. Th cursor begins on the right-hand side of the scree with a new or fully charged battery; as the batter runs down, the cursor moves towards the left. Replace the battery (or recharge if rechargeabl option is installed) when the cursor reaches the left hand side of the screen, or if the Battery Test a power-on reads below 6.5 Volts.

4.2. Bridging and Terminating

Using the SETUP switch, either a Line Terminating or a Line Bridging test setup may be selected. The Line Terminating setup is equivalent to an "off hook" condition on the phone line, and is selected by setting the switch to the TERM (down) position. In this setup the VNA-70A presents a fixed 600 Ohm AC load and a variable 50 to 300 Ohm DC load to the line. The Line Bridging test setup is the equivalent of an "on hook" condition on the phone line, and is selected by setting the SETUP switch to the BRDG (center) position. In this case the VNA-70A presents a high impedance to the line.

4.3. Voice Network Testing

The Voice Network Test mode is entered by placing the MODE switch in the TEST (up) position. To make measurements:

a. Insert the modular plug on the test lead into the LINE jack.

b. Connect the test lead clips to telephone line Tip and Ring.

c. Plug a telephone or butt-set into the SET jack.

The following information will appear on the screen:

4.3.1. DC Voltage appears in the upper left-hand section of the screen. A "+" or a "-" precedes the voltage value shown to indicate its polarity. The VNA-70A resolves voltage to the nearest ½ Volt, therefore the fractional DC voltage value is always a ".0" or a ".5". An overrange condition is indicated by a ↑↑↑ reading.

4.3.2. DC Loop Current appears in the lower left-hand section of the screen. A "+" or a "-" precedes the current value shown to indicate its polarity. The VNA-70A resolves current to the nearest ½ mA, therefore the fractional DC current value is always a ".0" or a ".5". An overrange condition is indicated by a ↑↑↑ reading.

CAUTION

OVERANGING THE DC MILLIAMMETER SECTION OF THE VNA-70A FOR EXTENDED PERIODS MAY RESULT IN INTERNAL DAMAGE

4.3.3. dBm is displayed in the upper right-hand section of the screen. With no input signal, an underrange reading, indicated by ↓↓↓ , is given. For signal inputs between -44 dBm and +4 dBm the "dB" mode is automatically selected. dB values are logarithmic in scale, therefore resolution decreases with signal level.

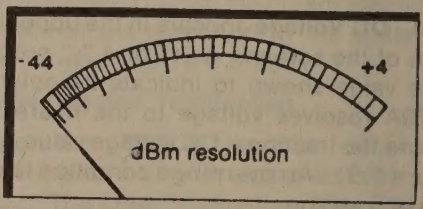


Figure 4-1: dBm Resolution, Analog

This may be visualized by recalling the familiar scale of an analog dB meter; indications are farther apart on the right-hand side and get closer together toward the left-hand side. See the SPECIFICATIONS section of this manual for dBm resolution at various input levels.

4.3.4. AC Voltage replaces the dB indication when the input level is above +4 dBm. In the AC Volts mode, readings may be taken up to 125 Volts. An overrange condition is indicated by a ↑↑↑ reading. Both dBm and AC Volts measurements are made using the True RMS conversion method and will give correct readings even if distortion, multiple frequencies or noise are present.

4.3.5. Frequency of the input signal appears in the lower right-hand section of the screen. The VNA-70A resolves frequency to the nearest cycle. An overrange condition is indicated by a ↑↑↑ reading. Note: due to noise, it is normal for a low frequency reading to sometimes be displayed even with no input.

4.3.6. Tone Generator mode is entered by pushing the SETUP switch up to TONE position. A "1004 Hz TONE" message appears on the screen indicating selection of this mode. The sinewave output should be taken from the LINE jack. Line termination is maintained while the tone is on, making it an ideal reference tone for transmission loss measurements. Tone output is at 0.0 dBm. It also makes a handy "buzz box" for identifying wire pairs in multi-line cables.

4.3.7. Resistance measurement to the nearest 100 Ohms is possible in two different modes, depending upon the selection of the Ohms switch:

LOOP OHMS is selected by moving the Ohms switch to the LOOP (up) position. This mode gives the effective resistance of a powered-up, or "wet loop" by measuring voltage and current, then calculating the resistance and displaying it on the screen. To use this Feature:

a. Connect the phone line to the LINE jack, leaving the SET jack unused.

b. Move the Ohms switch from the OFF (center) position to the LOOP position.

c. Follow the prompts on the screen, first switching the SETUP switch to BRDG, then to TERM. The calculated Ohms value will appear on the display.

DC OHMS is selected by moving the Ohms switch to the DC (down) position. The clip lead set should be connected to the LINE jack. While the SET jack is left unused. The test lead clips may be connected to measure the resistance of any unpowered, or "dry" circuit.

4.4. Digit Display

4.4.1. Placing the MODE switch in the DIGITS (center) position selects the Digit Display function. A flashing cursor in the upper left-hand corner of the screen indicates selection of this mode. In most cases, it is desirable to select the Line Bridging mode while using this feature. To use the Digit Display:

a. Insert the modular plug on the test lead into the LINE jack.

b. Connect the test lead clips to telephone line Tip and Ring.

c. Digits will appear on the screen at the location of the cursor. When the first line of the display is full, the cursor will "roll over" to the second line. When the second line is full, the cursor will "roll" back to the beginning of the first line. Therefore, if a digit string longer than thirty-two digits in length is received, the last thirty-two digits will be displayed.

d. Momentarily pushing the MODE switch down to the RESET position will clear the display.

4.4.2. The VNA-70A provides two different sensitivity levels for dial pulse detection. A switch located inside the battery compartment allows selection of the level most appropriate to a given application. To set the switch, remove the battery door on the back of the unit, and hold it so that the battery compartment is to your left.

If the VNA-70A is to read pulse digits at a Central Office or at a D.I.D. terminal, set the switch to the up position.

If the VNA-70A is to be used in PBX systems having a 24 Volt battery system, set the switch to the down position.

For digit monitoring at customer premises on standard 48 Volt systems, either setting will work although it is generally preferable to keep the switch in the down position unless CO/DID capability is specifically required.

4.5. Monitor Speaker

The VNA-70A is equipped with a built-in monitor speaker which may be used at any time. Set its volume to the desired level using the ON/OFF/VOLUME thumbwheel.

5. POWER SOURCE

The VNA-70A is equipped with a 9 Volt rechargeable Ni-Cad battery. When the battery runs down, recharge by inserting the plug from the recharging transformer into the Battery Charger Jack on the top of the VNA-70A and plugging the charging transformer into a 110 to 120 Volt AC source. Recharging time is approximately 12 hours.

The VNA-70A may also be operated from a standard 9 Volt alkaline battery. The battery is accessed by sliding off the removable cover on the back of the case. CAUTION: DO NOT ATTEMPT TO USE THE CHARGING TRANSFORMER IF AN ALKALINE BATTERY IS INSTALLED IN THE VNA-70A. USE THE CHARGING TRANSFORMER ONLY WHEN THE RECHARGEABLE NI-CAD BATTERY IS INSTALLED.

6. SPECIFICATIONS

Parameter	Min	Typ	Max	Unit
VOICE NETWORK ANALYZER:				
DC Volts:				
Range	+/-1		+/-99.5	Volts DC
Resolution	0.5			Volt
Accuracy	+/-1.0			%of FS

DC Milliamps:

Range	+/-1	+/-99.5	mA DC
Resolution	0.5		mA
Accuracy	+/-1.0		% of FS

AC Volts:

Range	3	125	Volts AC
Resolution	1		Volt
Accuracy	+/-2.0		% of FS
Frequency Range	16	1K	Hz
Conversion Method	True RMS		

Decibels:

Range	-44	+4	dBm
Resolution and Accuracy:			
-20 to +4 dBm	0.5		dB
-30 to -20 dBm	1.0		dB
-34 to -30 dBm	2.0		dB
-38 to -34 dBm	4.0		dB
-44 to -38 dBm	6.0		dB
Frequency Range	30	8K	Hz
Conversion Method	True RMS		
Reference Impedance	600		Ohms

Frequency:

Frequency Range	15	8K	Hz
Resolution	1		Hz
Accuracy	+/-0.2		% of FS
Minimum Input Level	-25		dBm
Maximum Input Level		125	Volts AC

DC Ohms:

Range	0	25K	Ohms
Resolution	100		Ohms
Accuracy	+/-2.0		% of FS

Loop Ohms:

Range	100	5K	Ohms
Resolution	100		Ohms
Voltage Range (Bridge)	20	60	Volts DC
Current Range	10	90	mA DC

TONE GENERATOR:

Frequency	1004		Hz
Accuracy	+/-0.15		%
Level	-0.5	0	dBm
Impedance	600		Ohms

INTERNAL LOAD:

Impedance		600		Ohms
Maximum Input Level			+4	dBm
Frequency Range	300		8K	Hz
DC Equivalent Resistance	50		300	Ohms

DIGIT DISPLAY:

Readout:

Display Capacity			32	digits
Display Font	Full alphanumeric			
Display Type	Liquid Crystal			

DTMF Input:

Input Level	-26		+3	dBm
Twist	-8		+8	dB
Frequency Deviation Accept Limit			+/-2.5	%
Frequency Deviation Reject Limit	+/-3.5			%
Tone Duration Accept	40			mS
Interdigit Pause Accept	40			mS
Characters Displayed	0-9	*, #, A, B, C, D		
Input Impedance		100		kOhms

Pulse Dial Input:

CO/DID Level:				
Off-Hook Voltage	0		41	V DC
On-Hook Voltage	44	48	100	V DC
PBX/Customer Prem Level:				
Off-Hook Voltage	0		20	V DC
On Hook Voltage	22	48	100	V DC
Pulse Rate	7	10	22	PPS
Interdigit Time	250			mS
Characters Displayed		0-9		

GENERAL:

Dimensions	4"h x 7.5"w x 1.375"d			
Operating Temperature	0		60	°C
Rechargeable Battery	9 Volt Nickel-Cadmium			
Usage Time		3		hours
Recharge Time	8	12	16	hours
Alkaline Battery	Duacell MN-1604 or equiv.			
Alkaline Battery Life		35		hours

7. APPLICATION NOTES

Probably the most unique single feature of the VNA-70A Voice network Analyzer is its ability to make simultaneous measurements of line voltage, loop current, dB level and frequency. Not only does this greatly simplify the measurement process by eliminating the need for mode and range switching. but it also lets you monitor the interaction of these parameters in everyday situations—a vary important feature in telephony. It's actually equivalent to having four separate test instruments hooked up at once. The following examples show how you can put this power to work for you to make your daily work faster, easier and more accurate.

7.1. Telephone Line Testing

7.1.1. Stand-Alone Use

With the VNA-70A's MODE switch in the TEST position and the SETUP switch in the BRIDGE (center) position, connect the phone line to the LINE jack.

The DC Volts section of the display screen reads the C.O. talk battery voltage.

The DCmA section shows a 00.0 reading, since the line is "on-hook" and no current is being drawn.

The dB section will either give an underrange indication or, if noise is present on the line, a low dB reading.

No meaningful frequency measurement will be shown unless noise on the line is of a constant frequency and is greater than -25 dBm.

Now move the SETUP switch to the TERM (down) position.

The DC Volts section reads the terminated, or off-hook, voltage. Normally this reading is in the range of 4 to 18 volts.

The DCmA section shows the loop current drawn by the VNA-70A's internal load.

Since the line is seized, a dial tone should be heard on the VNA-70A's monitor speaker. Set the volume to the desired level using the ON/OFF/VOLUME thumbwheel. The dB level of the dial tone is indicated in the dB section of the display screen. You'll get an accurate reading of this multi-tone signal because of the VNA-70A's true RMS measurement system.

The frequency section will read out the stronger of the two dial tone signals (either 350 or 440 Hz in most cases).

7.1.2. Butt-Set Use

With the VNA-70A's MODE switch in the TEST position, connect a butt-set to the SET jack and set the SETUP switch on the VNA-70A to the BRIDGE

(center) position. Now connect the phone line to the LINE jack.

With the butt-set off hook:

The DC Volts section on the display screen shows the terminated line voltage.

The DCmA section shows loop current drawn by the butt-set.

The dB and frequency sections give dial tone readings.

7.1.3. Ringback

Use the butt-set to dial a local C.O. ringback number. When the ringing signal is returned, its voltage will appear on the display screen in place of a dB measurement. The ringing frequency is also shown on the screen. This is a very useful feature in checking out frequency-selective ringing used in many party-line systems. If your butt-set does not have a ringer, you can measure the ringer voltage under load by substituting it with a telephone.

7.1.4. Noise

Dial a C. O. quiet termination with the butt-set. Switch in the VNA-70A's built-in load by setting the SETUP switch to the TERM (down) position. Now hang up the butt-set. The VNA-70A will hold the line and provide a precise 600 Ohm quiet termination on

your end of the line. Broad-band (unweighted) noise may now be read directly from the dB section of the display screen. When you've finished your measurement, switch out the VNA-70A's internal load to release the line by settling the SETUP switch to the BRDG (center) position.

7.1.5. Loop Resistance

Excessive loop resistance will impair the performance of any device connected to a telephone line. At installation time, checking the resistance of a new loop will help assure good performance. If the loop is already connected to the C.O., use the VNA-70A's LOOP resistance mode to test it. Unpowered, or "dry" loops may be tested by shorting one end and checking at the other end using the DC resistance mode. In general, loops should be in the range of 100 to 2200 Ohms for acceptable performance.

Troublesome loops which have already been in service for some time may have interconnections or splices which have deteriorated. An excessively high loop resistance will reveal this problem. If loop resistance cannot be measured by the VNA-70A and a "LINE VOLTAGE TOO LOW" message is given on the screen, try measuring the DC voltage with the SETUP switch in the BRDG position. Assuming the loop is supposed to be connected to the C.O., a very

low voltage reading (0.0 to 2.0 Volts) indicates that the loop is completely open. This is a fairly common occurrence, and the fault is frequently found in the customer premises wiring.

7.1.6. Milliwatt Receive

Start with VNA-70A in the BRDG mode. Use the butt-set to dial a local C.O. milliwatt number. Switch the VNA-70A to the TERM mode. Now hang up the butt-set. The VNA-70A will hold the line and provide a precise 600 Ohm quiet termination.

Since the C.O. sends its test tone at 0 dBm, the dB reading on the screen gives a direct indication of the loss at your end of the line. When you've finished your measurement, switch the VNA-70A back to BRDG to release the line.

7.1.7. Frequency Receive

You can easily make loss and slope measurements by receiving tones from a generator on the other end of the line. With your line terminated using the VNA-70A's internal load, you can simultaneously read the transmitted tone's level and frequency.

7.1.8. Miliwatt Send

You can send a milliwatt-level signal by first using the butt-set to dial up the receiving end and then switching in the VNA-70A's 1004 Hz tone generator (setting the SETUP switch to the up position) and hanging up the butt-set. The VNA-70A now holds the line while transmitting a 0 dBm signal. When you're finished sending, take the butt-set off-hook again and switch off the generator by returning the SETUP switch to the BRIDGE (center) position. A VNA-70A at the other end of the line may then be used to send a 1004 Hz tone to you. Measure its level with your VNA-70A terminating the line and the butt-set on-hook. This test permits a transmit/receive loss comparison to be made on 4-wire circuits—a particularly important test in long distance service. Since the VNA-70A is a completely self-powered device, it may also be used to make these tests on "dry" (nonpowered) lines.

Keep in mind that the 1004 Hz tone generator makes a handy tone tracer when you're checking out system wiring. Simply connect the VNA-70A acress the wire pair and switch on the tone generator. Now use your butt-set at the other end to trace the pair out.

7.2. Equipment Testing

7.2.1. Telephone Sets

By connecting a telephone to the SET jack an
the phone line to the LINE jack, all of the importa
parameters of telephone operation may be quick
and easily tested. For these tests, the SETUP switc
should be in the BRIDGE position.

When the phone receiver is lifted, current draw
by the instrument will be shown in the DCm
section of the display screen. Normally this will b
in the range of 15 to 90 mA.

The transmit level of a tone dialing phone may b
tested by pressing a digit on the phone keypad an
reading the dB level on the display screen.
Individual tone frequencies may be measured b
pressing two adjacent buttons at once. Fo
example, if "1" and "2" are pressed at the same tim
the row 1 tone will be generated by itself. Pressin
"1" and "4" at the same time will generate th
column 1 tone by itself. Pressing "2" and "5
generates column 2, and so on. Using th
technique, each row and column tone generated b
the telephone under test may be checked fo
conformance to the standard frequencies:

Tone	Buttons to Push	Standard Frequency
row 1	"1" and "2"	697 Hz
row 2	"4" and "5"	770 Hz
row 3	"7" and "8"	852 Hz
row 4	"*" and "0"	941 Hz
column 1	"1" and "4"	1209 Hz
column 2	"2" and "5"	1336 Hz
column 3	"3" and "6"	1477 Hz

The "twist", or level difference between the tones may be measured by noting the dB levels of the tones as the frequency measurements are made.

EXTRA NO-CHARGE HINT: the older tone telephones, such as the familiar Western Electric 2500, sometimes won't tone dial when hooked to a line, even though the rest of the instrument works okay. Most of these phones were not equipped with polarity guards and are, as a result, polarity sensitive. Try reversing Tip and Ring—chances are the dial pad will now work.

Now set the VNA-70A MODE switch to the DIGITS position. This will enable you to see if the phone is dialing the same number that you are pressing on the keypad. This test will also work on pulse-dial phones.

7.2.2. Key/PBX Demarc

If the VNA-70A is connected at the demarcation (service entr,') point, all of the above tests can be made on every phone on the line. This setup lets you compare performance of the phones.

Connect the LINE jack to the phone line entering the premises. Connect the SET jack to the phone system to be served by the line. Set the SETUP switch to the BRIDGE (center) position.

7.2.3. Auto Dialers

Use the VNA-70A as a diagnostic and programming aid for checking out dialers used in speed calling, long distance access, and security alarm signaling. Dialing patterns may be checked in the DIGITS mode with the phone line connected to the LINE jack and the dialer connected to the SET jack (the VNA-70A should be in the BRDG mode). Switch to the TEST mode to test line interface parameters.

7.2.4. FAX Telephone Line Testing

Connect the phone line to the LINE jack on the VNA-70A. The MODE switch should be in the TEST (up) position; the SETUP switch should be in the BRDG position and the OHMS switch should be in

the OFF position. Connect the FAX machine to the SET jack on the VNA-70A.

With the FAX machine idle, that is, neither sending or receiving, make the following observations:

a. DC line voltage should read between 42.0 and 53.0 Volts. A reading outside this range normally indicates a telephone line problem.

b. DC line current ideally should read 00.0; however, due to noise, it may read +00.5 or -00.5. Any reading greater than this may indicate a DC leakage problem in the FAX machine.

c. The dB and Frequency sections of the screen will not display meaningful information at this time unless there is excessive noise or tones on the line. Presence of noise above the -25.0 dB level could impair FAX operation. Verify any such readings by turning up the volume of the monitor speaker.

Now lift the handset of the FAX machine while observing the display screen of the VNA-70A:

a. DC Volts should read between 4.0 and 18.0. If the reading is lower than 4.0 Volts, a problem may exist with the FAX machine, but it is more

likely that the phone line is excessively long or has a bad connection.

b. DC mA should read between 15.0 and 90.0 milliamperes. A reading below 15.0 milliamperes likely indicates a bad connection.

c. Dial tone can be heard by sdjusting the volume control on the VNA-70A. A level of between -20.0 dBm and -12.0 dBm should be seen in the upper right-hand corner of the display.

d. The Frequency section of the display should read between 350 and 440 Hz.

Now place the MODE switch on the VNA-70A in the DIGITS (center) position. The touchpad on the FAX machine may now be tested by pressing each number on the pad and checking for its display on the VNA-70A screen. Auto-dialing FAX machines may also be tested using this feature.

Return the MODE switch to the TEST position and place the FAX handset back "on-hook". Having someone now call up the FAX machine will allow testing of its response to ringing signals. The FAX machine should answer after the programmed number of rings. If the voltage measured in the upper right-hand section of the VNA-70A display screen is greater than 25 VAC, the FAX machine

should respond. A lower voltage may indicate a faulty phone line.

These tests should provide a general indication of telephone line quality. Major deviations from the above values indicate potential telephone line problems that will impair the performance of FAX communications.

7.2.5. FAX to FAX Testing

These procedures are performed with a FAX machine at each end of the line. It should be noted that the tones and levels given in the following examples are present for very short periods of time and that the VNA-70A updates its display one time per second. Therefore, it may not be possible to read the shorter tone bursts in every case. Care must be used in observing the display so that readings are not missed.

With the VNA-70A connected as in the above procedures, initiate a call from your FAX machine to the distant one. Observe that, after dialing the last digit, your FAX machine will send a 1100 Hz tone for ½ second at a nominal level of -9.0 dBm. This cycle may repeat at 3 second intervals.

Audible ringback should be heard in the monitor speaker. Two seconds after answering, the

receiving machine should send a 2100 Hz tone for three seconds at a level of -9.0 dBm. This tone should be received at your end of the line at a level greater than -44.0 dBm. An underrange indication in the dBm section of your VNA-70A's display indicates excessive line loss.

The distant machine will now send data tones to your machine. The lower right-hand section of the VNA-70A display screen will indicate frequencies between 1550 Hz and 1750 Hz. During this period, a single burst of 1850 Hz should be seen. These tones are sent at a nominal level of -9.0 dBm, and you should receive them at a level greater than -44.0 dBm.

These tone exchanges will continue until the two machines are synchronized. This exchange of tones is known as "bird calls" because of the chirpy sound it produces in the monitor speaker.

After synchronization, another series of tones at the same frequencies and levels will be exchanged as the actual image information is passed from one machine to the other. At the end of this period, both machines will disconnect simultaneously.

If all of the above indications are normal and documents cannot be transferred in one or both directions, one or both of the FAX machines should be suspected.

8. LIMITED WARRANTY

Within 90 days of original purchase, the factory will, at its option, either repair or replace this product if it fails to function because of defects in materials or workmanship. To qualify for product service under this warranty, the purchaser must return it to factory postpaid with proof of purchase.

Warranty does not cover the following:

a. batteries;
b. exterior finishes;
c. damage resulting from accidents, misuse or tampering;
d. damage resulting from exposure to environmental extremes such as water humidity or temperature;
e. units that have been modified or altered

All implied warranties including any implied warranty or merchantibility or fitness for any particular purpose are limited in duration to one year from date of original purchase.

The factory assumes no responsibility for consequential damages resulting from the use of this product.

NOTE: The VNA-70A is for temporar connection to telephone lines for test purpose only. It is intended for use only by qualifie technicians familiar with telephone line servicin problems. The VNA-70A is an FCC registere device.

Any repair or recalibration of the instrument mus be performed by Metro Tel in order to maintai conformance to required standards. For servic under warranty, or out of warranty, return the uni to:

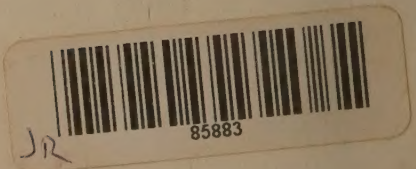
Metro Tel
490 Gianni Street
Santa Clara, CA 95054
408-988-5200

SEE BACK

Intentionally Blank

Metro Tel Corp

Manufacturing/Western Sales
250 South Milpitas Blvd
Milpitas, CA 95035
408-946-4600 tel



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